Is more activity always better?

A department-wide study of relationships between classroom practices and student performance

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Inspired by last year at SABER…

Scott Freeman *et al*, PNAS 2014:

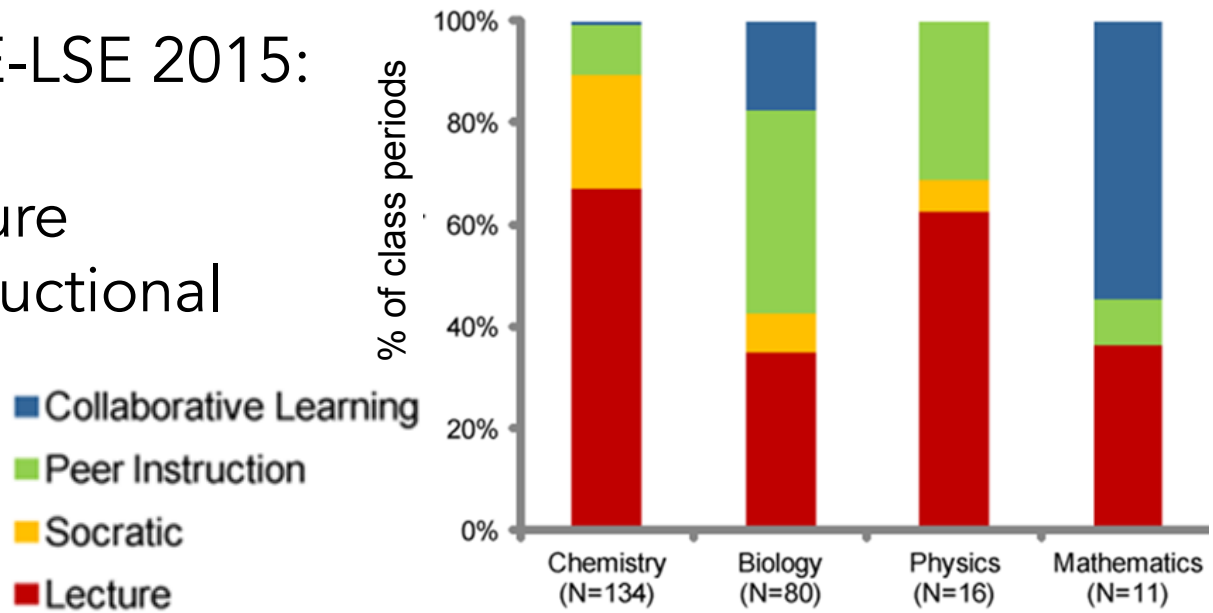
"Active learning increases student performance in science, engineering, and mathematics"

End of lecture: The future of evidence-based teaching

Sub-subtitle: PLEASE understand how important you are

Travis Lund *et al*, CBE-LSE 2015:

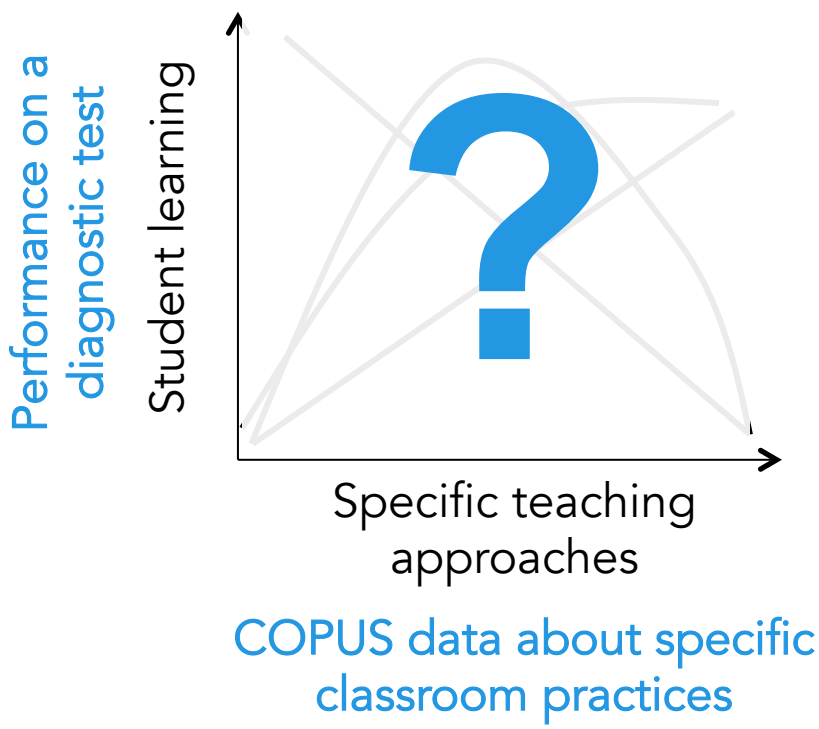
Using COPUS to capture department-wide instructional practices.



Next Generation Research Questions…

- Do different active learning techniques contribute more to student learning than others?
- Is more always better?

Our operationalized variables (what we measured):



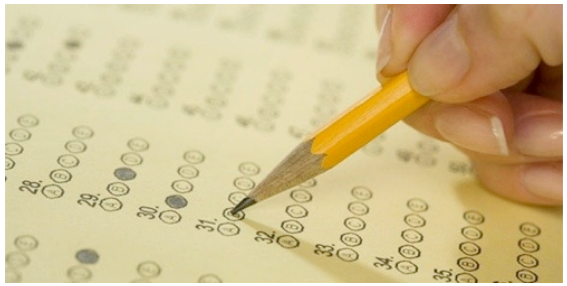
Scope and Tools

COPUS observations

- 33 lecture sections in 17 biology classes
- For each, observed "a typical week" (~3 hours)

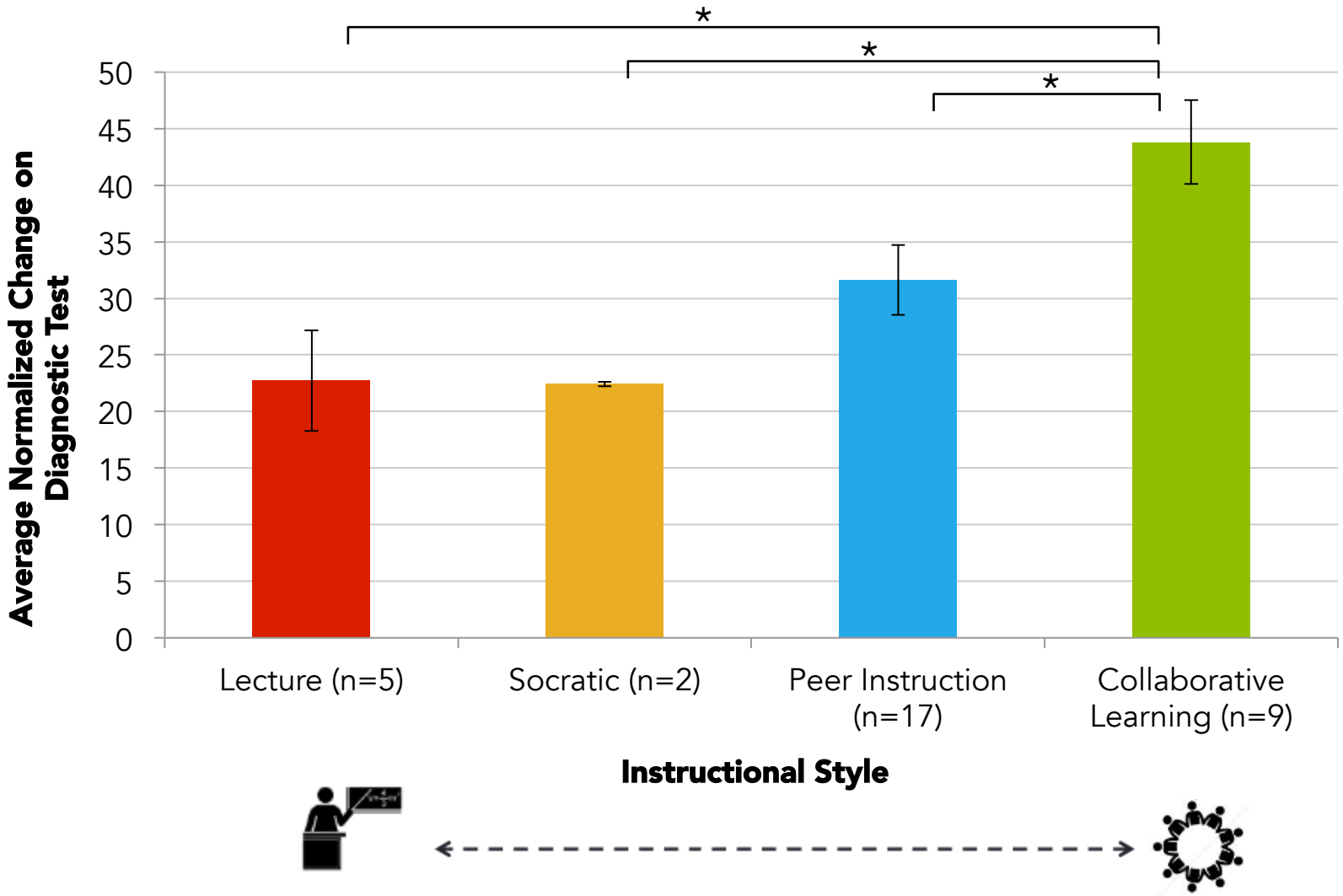
Course Year	# Course Sections
1	13
2	9
3	5
4	6

Diagnostic tests



- One test per course; developed with instructor
- ~10-15 multiple choice concept questions
- 217 questions total, compiled from validated inventories or developed with instructors
- Over 6500 (non-unique) students tested

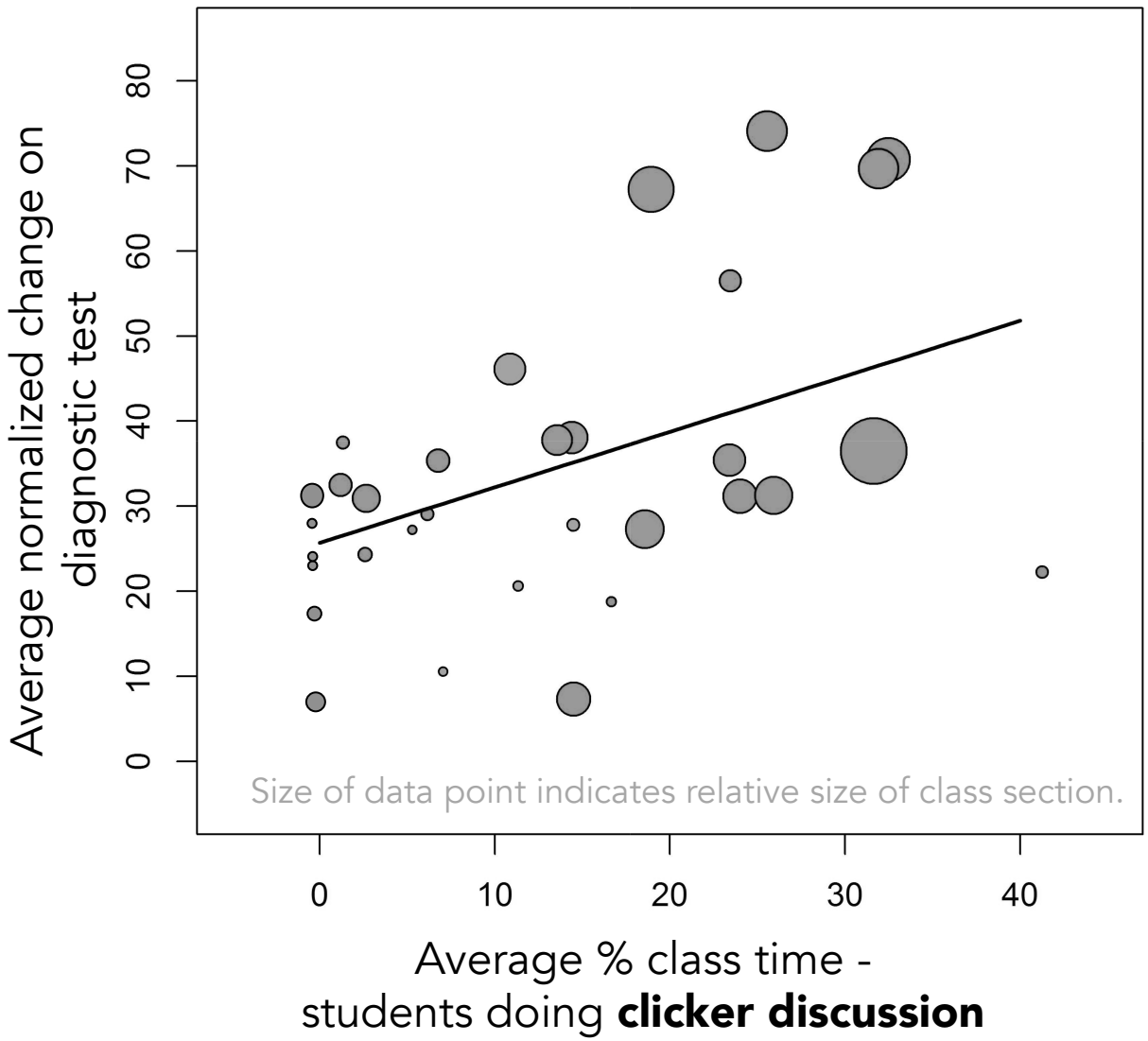
Instructional styles & learning gains



Normalized change for a given student (from Marx & Cummings 2007):
For increases: (Post – Pre) / (100 – Pre) For decreases: (Post – Pre) / (Pre)

* $p<0.05$

Peer discussion using clickers



82% of our classes spend at least some time on peer discussion with clickers.

Here, more is better…
to a point.

$F_{1,32} = 5.51$, $r^2 = 0.27$, $p = 0.03$

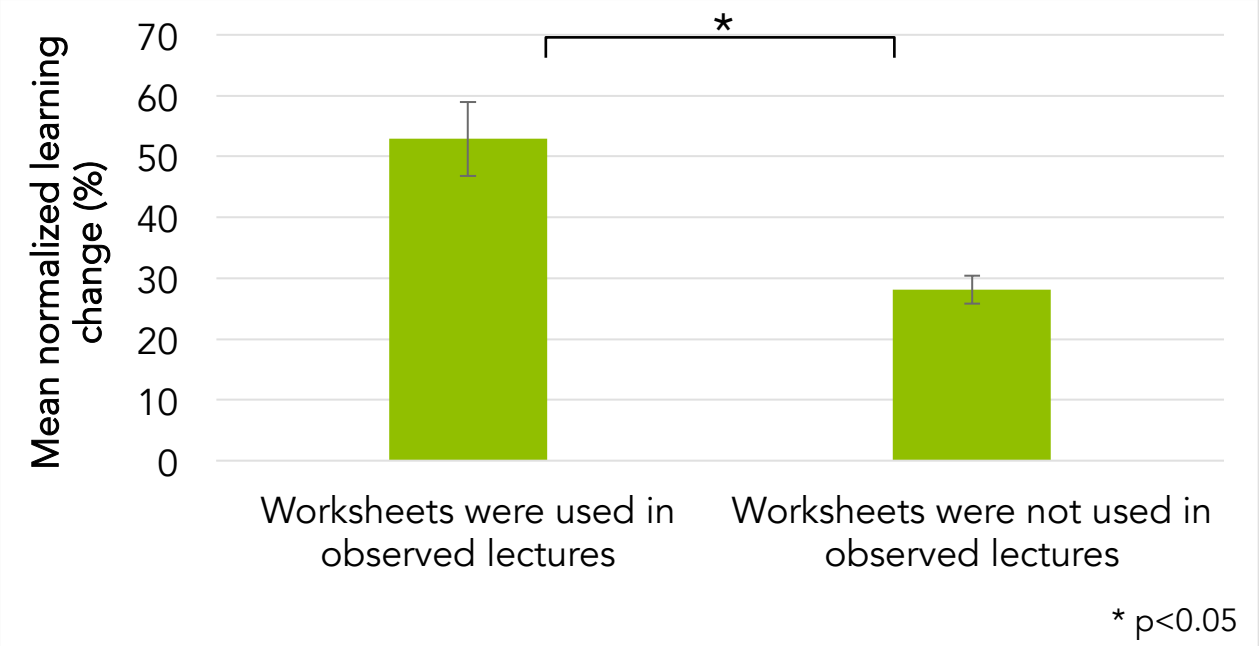
Impact of the presence/absence of a given activity

Class level	# sections	Section size	% sections using groupwork
Years 1&2	22	242 +/- 48	100%

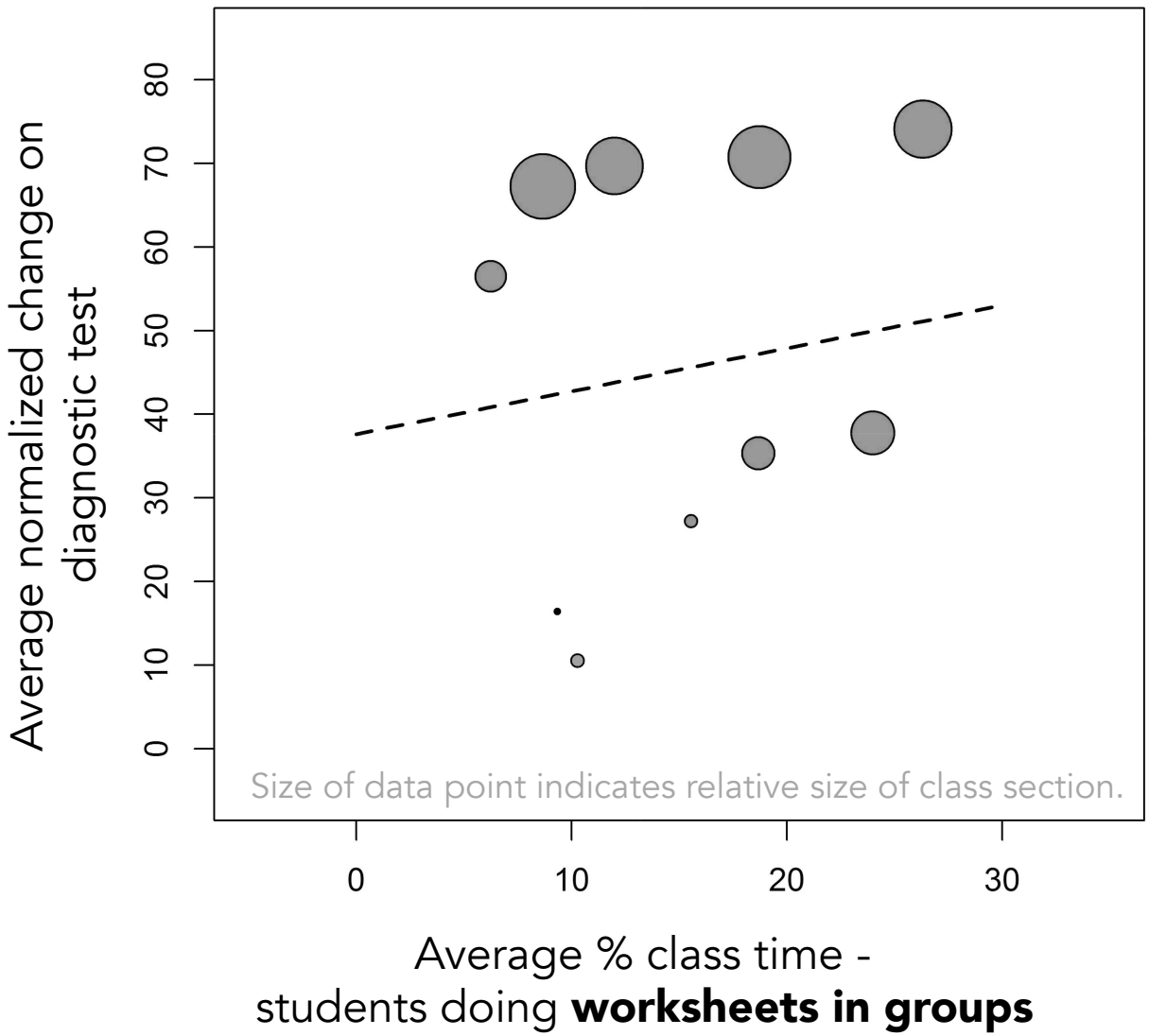
100% using clickers
41% using worksheets
91% using 'other groupwork'

Using the 1st/2nd year data:

Use of worksheets, in particular, supports student learning



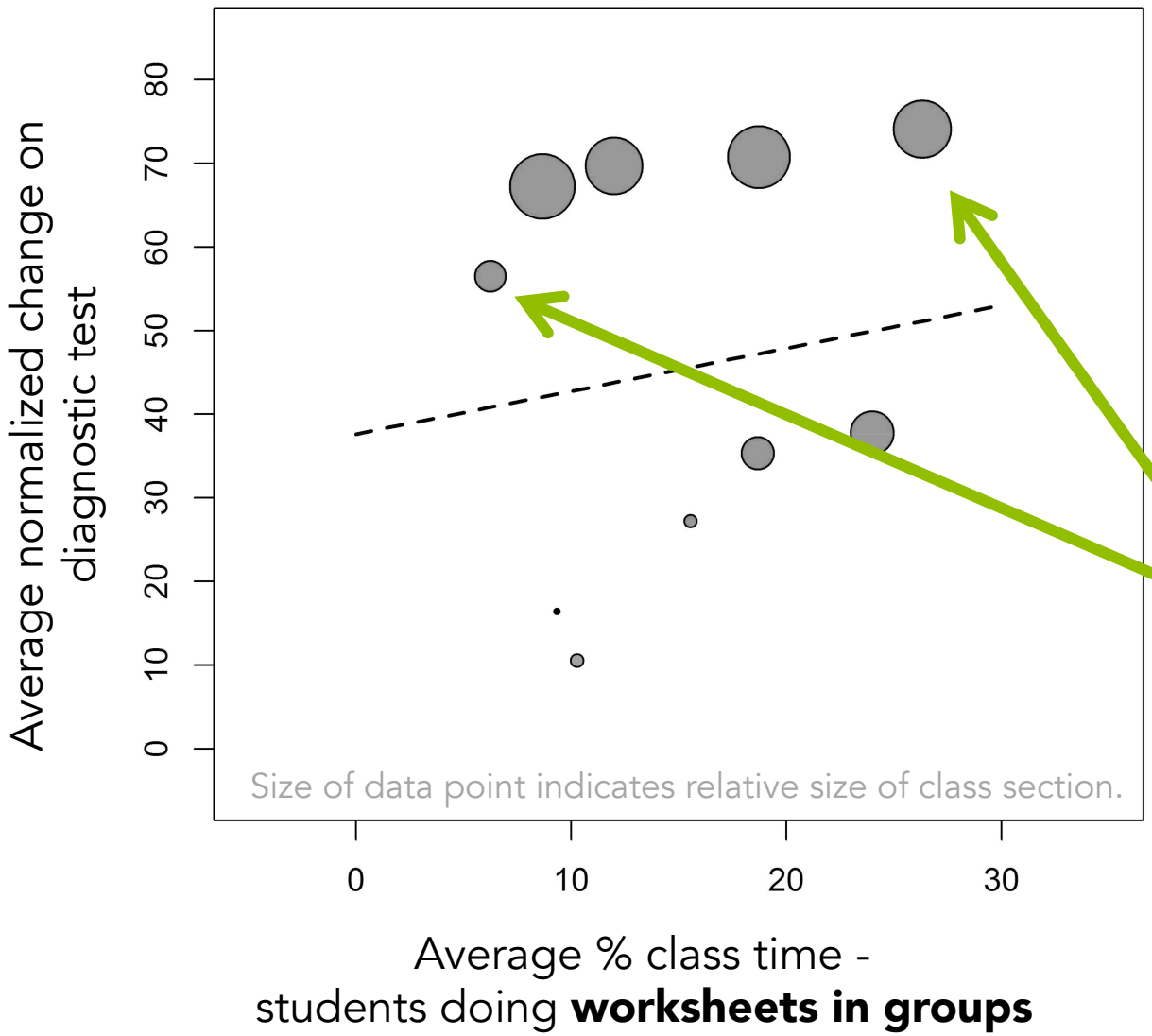
For worksheets, is more time-on-task better?



A trend, but the fit is not significant.

How to account for the variability between sections?

For worksheets, is more time-on-task better?

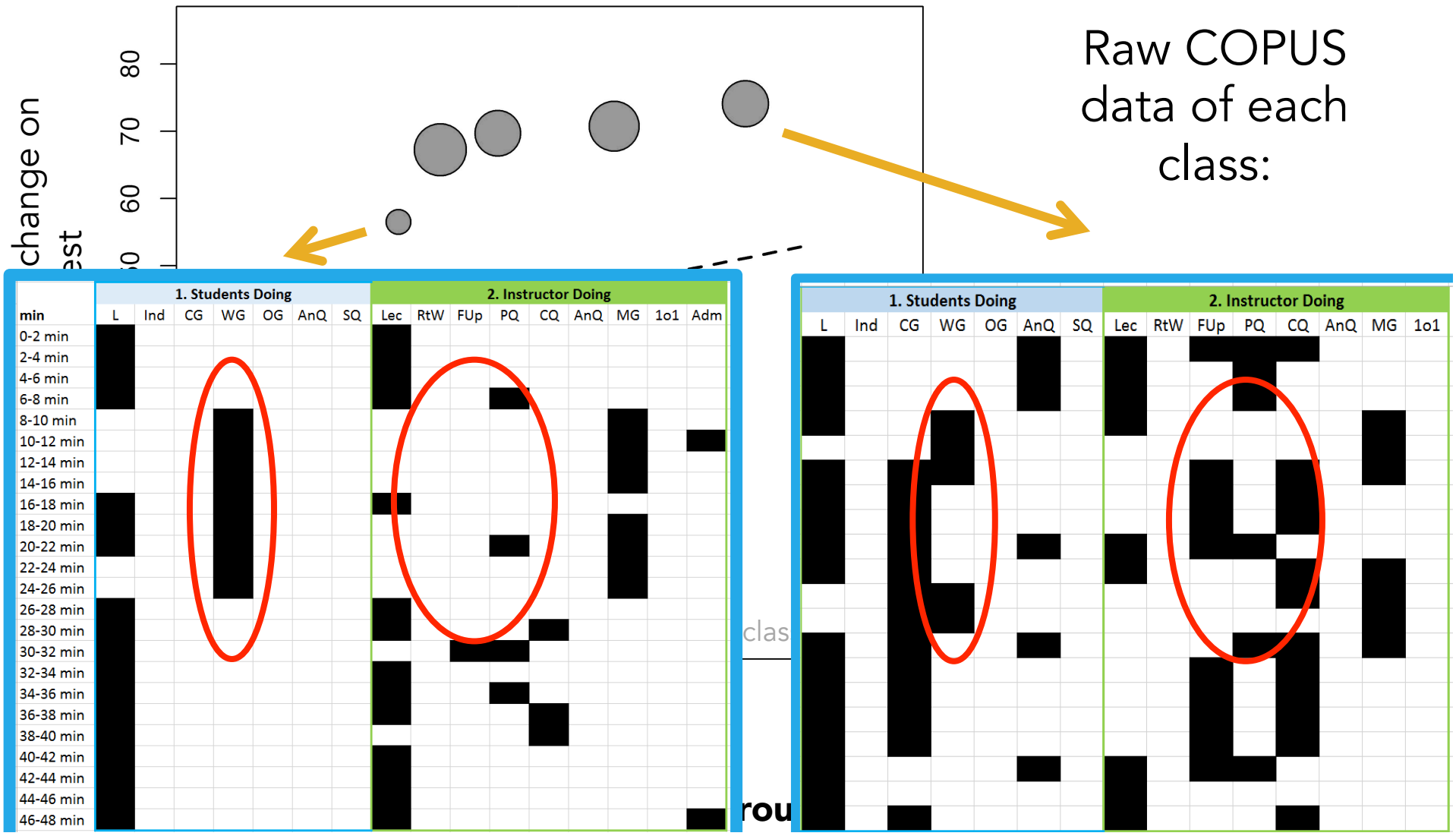


A trend, but the fit is not significant.

How to account for the variability between sections?

Can we rule out worksheet 'quality'? Two different sections using the same worksheet

Class time, choreography, and concurrent activities



Conclusions & Next Steps

Instructional style has a big impact on student learning!

Clickers (at least for us) are a valuable use of class time

- Even trying clicker peer discussion in a small way is beneficial
- Choreography has been well-developed/supported

Worksheets: promising, but:

- Good potential for structured work and feedback
- We need to think carefully about worksheet choreography within the class, and other factors

More active is generally better… but the data doesn't account for all of the variability:

- Current data is not yet a strong predictor
- Need stronger analyses of COPUS, and need other tools!

Thank you!

Validated concept questions - topic	Author
Biomechanics	Knudsen et al., 2003
Genetics	Smith et al., 2008
Osmosis	Fisher et al., 2011
Meiosis	Kalas et al., 2013
Molecular Biology	Couch et al., 2014
Phylogenetic trees	Baum et al., 2010
Genetic drift	Price et al., 2013
Dominance	Abraham et al., 2014
Biochemistry	Villafane et al., 2011
Population Dynamics	Hansen et al.
Biological Experimental Design	Deane et al., 2014
Transcription and Translation	Taylor et al.
Carbon cycling	Cordero Maskiewicz et al., 2012
Physiology	Michael et al., 2002; Michael, 1998 & 1999.
Molecular/Cell Biology	Shi et al., 2010
Intro Biology	Klymkowsky et al., 2010
Photosynthesis	Parker et al, 2012
Enzyme-substrate interactions	Linenberger and Bretz, 2012